Capital Asset Pricing Model and Arbitrage Pricing Theory in the Italian Stock Market: an Empirical Study

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ABSTRACT

The Italian stock market (ISM) has interesting characteristics. Over 40% of the shares, in a sample of 30 shares, together with the Mibtel market index, are normally distributed. This suggests that the returns distribution of the ISM as a whole may be normal, in contrast to the findings of Mandelbrot (1963) and Fama (1965). Empirical tests in this study suggest that the relationships between β and return in the ISM over the period January 1990 – June 2001 is weak, and the Capital Asset Pricing Model (CAPM) has poor overall explanatory power. The Arbitrage Pricing Theory (APT), which allows multiple sources of systematic risks to be taken into account, performs better than the CAPM, in all the tests considered. Shares and portfolios in the ISM seem to be significantly influenced by a number of systematic forces and their behaviour can be explained only through the combined explanatory power of several factors or macroeconomic variables. Factor analysis replaces the arbitrary and controversial search for factors of the APT by "trial and error" with a real systematic and scientific approach.

The behaviour of share prices, and the relationship between risk and return in financial markets, have long been of interest to researchers. In 1905, a young scientist named Albert Einstein, seeking to demonstrate the existence of atoms, developed an elegant theory based on Brownian motion. Einstein explained Brownian motion the same year he proposed the theory of relativity. At that time his results were considered completely revolutionary. However, the theory of Brownian motion had been discovered five years earlier by a young French doctoral candidate named Louis Bachelier. He, too, was trying to explain certain complex movements: stock prices on the Paris Bourse.

Bachelier was the first to study the fluctuations in the prices of stocks and shares and their probability distributions. His PhD thesis contained remarkable results, which anticipated not only Einstein's theory of Brownian motion but also many of the modern concepts of theoretical finance. Bachelier received a respectable "*mention honorable*", but his theory did not receive much attention and he died in provincial obscurity, in 1946 (Holt (1997)).

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The full potential of Bachelier's theory was only realized some 50 years later by Mandelbrot (1963) and Fama (1965). Their findings that the variance of returns is not constant over time (heteroscedasticity) and that the distribution of price changes were not Gaussian but leptokurtic, are among the foundations of modern financial theory. Fama concluded that the empirical distributions of share prices followed not a Gaussian but a Stable Paretian distribution with characteristic exponent less than 2, that is, with finite mean but infinite variance.

However, it was only with the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) that one of the important problems of modern financial economics was formalized: the quantification of the trade-off between risk and expected return. Proponents of the the CAPM argue that β, a measure of systematic risk relative to the market portfolio, is the sole determinant of return. Any additional variability caused by events peculiar to the individual asset can be *"diversified away"*: capital markets do not reward risks borne unnecessarily.

In 1976 Ross introduced the Arbitrage Pricing Theory (APT) as an alternative to the CAPM. The APT has the potential to overcome CAPM weaknesses: it requires less and more realistic assumptions to be generated by a simple arbitrage argument and its explanatory power is potentially better since it is a multifactor model. However, the power and the generality of the APT are its main strength and weakness: the APT permits the researchers to choose whatever factors provide the best explanation for the data but it cannot explain variation in asset return in terms of a limited number of easily identifiable factors. In contrast, CAPM theory is intuitive and easy to apply.

An enormous amount of literature has been written on the two models. It is widely believed that the APT performs very well compared to the CAPM and provides an attractive alternative. However, the academic world is still deeply divided between beta defenders (Sharpe (1964, 1998), Cheng (1995), Grundy and Malkiel (1996)), APT advocates (Chen (1983), Chen, Roll and Ross (1986), Fama and French (1992), Groeneworld and Fraser (1997)) and researchers questioning the testability of both methods (Roll (1977), Shanken (1983), Dhrymes, Friend and Gultekin(1984)).

The focus of this paper is to test and compare the Capital asset Pricing Model and Arbitrage Pricing Theory in the Italian stock market. In order to test the models, it is important to understand the characteristics of the ISM. Sections 2 and 3 analyze the empirical evidence on the behaviour of stock prices in the Italian market. The main body of the paper (sections 3 and 4) tests and compares CAPM and APT with artificial factors, using a variety of tests, to assess which model performs better in explaining the behaviour of share prices in the ISM.

The artificial factors of the APT are determined with factor analysis (FA) techniques. The significant factors affecting share prices behaviour are used in section 5 as a base for the study of the relationship between share prices and Italian macroeconomic variables.

1 THE ARBITRAGE PRICING THEORY (APT)

1.1 A Brief Review of APT

The APT begins with an assumption on the return generating factors. Assuming that asset markets are perfectly competitive and frictionless each asset return is linearly related to k factors plus its own idiosyncratic disturbance:

$$R_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + ... + \lambda_k b_{ik} + \varepsilon_i \tag{1}$$

If there exists a riskless (or a "zero beta") asset, its return will be λ_0; λ_j can be interpreted as the risk premium corresponding to factor j, and b_{ij} is the sensitivity of the return of asset i to the factor j.

Equation (1) can most compactly be expressed as

$$R_i = a + \mathbf{b}'\boldsymbol{\lambda} + \varepsilon_i \tag{2}$$

$$E[\varepsilon_i | \boldsymbol{\lambda}] = 0 \tag{3}$$

where R_i is the return for asset *i*, *a* is the intercept for the factor model, **b** is a (k,1) vector of asset sensitivities for asset *i*, $\boldsymbol{\lambda}$ is a (k,1) vector of common factor realisations and ε_i is the disturbance term.

1.2 Factor Analysis

Most empirical work on the APT is based on the use of factor analysis or principal components analysis to identify the factors. The k principal components of an (n,k) **X** matrix of n observations of k variables (shares or portfolios) can be expressed by the (n,k) matrix **Z**

$$\mathbf{Z} = \mathbf{X}\mathbf{A} \qquad (4)$$

where A is the eigenvectors matrix**.** From the above equation we can reconstruct **X** as

$$\mathbf{X} = \mathbf{Z}\mathbf{A}' \qquad (5)$$

being A orthogonal. We thus reconstruct the original vector space, spanned by the k column vectors in matrix **X** with the vector space spanned by the column vectors (factors) of matrix $\mathbf{Z}$ with coefficient in A (eigenvectors matrix). If we retain less than k principal components, equation (5) would have to be replaced by

$$\mathbf{X} = \tilde{\mathbf{Z}}\tilde{\mathbf{A}}' + \mathbf{U} \qquad (6)$$

where $\tilde{\mathbf{Z}}$ and $\tilde{\mathbf{A}}$ denote the submatrices of **Z** and **A** relative to the retained components and corresponding eigenvectors, and **U** is a matrix of errors. The factor vectors in matrix $\tilde{\mathbf{Z}}$ calculated from either the covariance or correlation matrix represent directions in a subspace within the original vector space. This contains a large portion of the total variability in the original set. If a relatively small number of principal components account for a substantial proportion of the variance, then equation (6) is a convenient and useful way to express **X** with a reduced number of variables.

2 THE ITALIAN STOCK MARKET (ISM)

The Italian Stock Market traces its origins back 200 years, to the institution of the *"Borsa di Commercio"* with Napoleonic decree on the 6th of February 1808. Its first regulatory body was approved in 1913, and subsequently modified in 1986 and 1997. In 1997 the Italian Stock Market was privatized to become Borsa Italiana Spa (Italian Exchange), a public limited company. In the last few years, two main events have taken place (Brunetti (1999)):

- The ISM has grown remarkably in terms of market capitalization. From 1992 to 2000 its market capitalization grew from ∈ 95,861m (12.2% of GDP) to

∈818,834m (70.2% of GDP), an increase of 754%. In the last 4 years (1996-2000) the ISM has experienced compound growth of 42% p.a. (see fig 1);

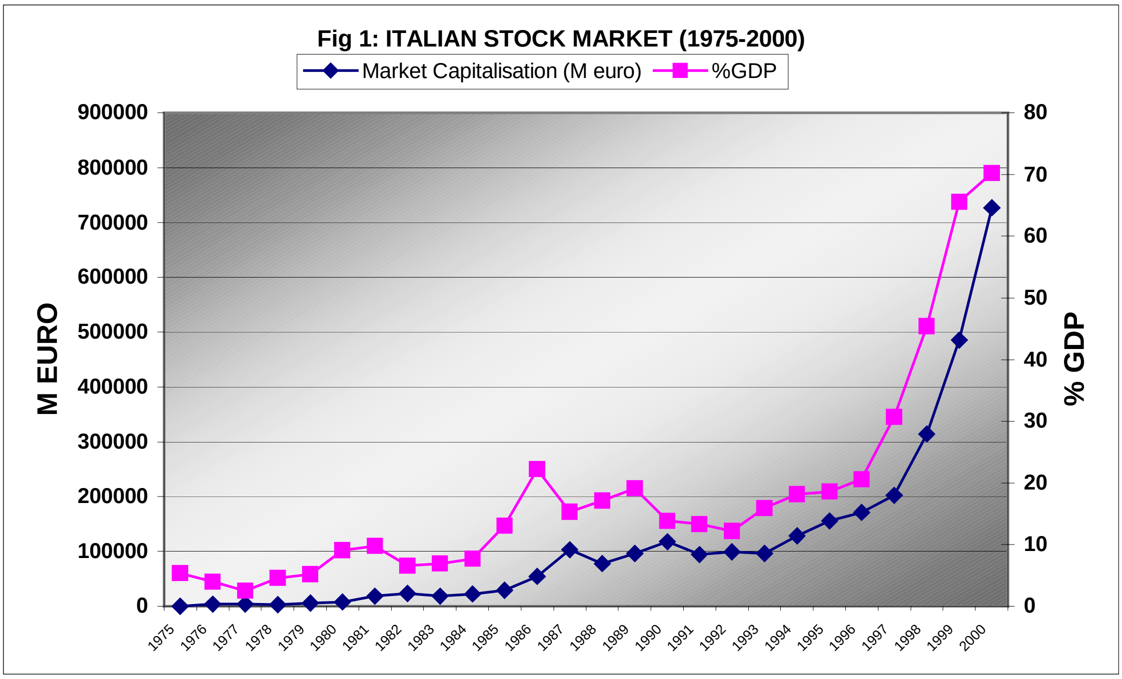
- Technological progress has led to increasingly integrated financial services across sectors and countries., In 1999 the ISM signed a "Memorandum Of Understanding" with 7 European exchanges (Amsterdam, Brussels, Frankfurt, London, Madrid, Paris, Zurich) for the creation of a Pan-European stock market.

At the end of year 2000 there were 297 listed companies on the ISM (of which 6 were foreign companies) giving a total market capitalization of ∈818.4 bn. (see Table 1). The ISM can therefore be considered an expanding market and it is interesting to study the extent to which the Italian market is correlated with the major world stock markets (US, UK, France and Germany). Table 2 shows the correlation matrix with monthly returns. The market indices used are the FTSE world indexes. The correlation between markets can be interpreted as a raw measure of market integration.

Consistent with the findings of Brunetti (1999) for daily returns, the ISM is strongly correlated with European markets, especially France. The lowest correlation is between the Italian and US returns. It is also evident that the correlation between markets is dramatically increasing, and that the ISM is becoming more and more integrated with other equity markets. However, a key feature of table (2) is that, among the European markets, the ISM is still the one with the lowest correlation.

Table 1 : Market Capitalisation of the ISM (1975-2000)

YEAR	Companies listed	Market Capitalisation (M euro)	%GDP
1975	154	3835	5,4
1976	156	3612	4
1977	156	2774	2,5
1978	171	6085	4,6
1979	173	8269	5,2
1980	169	18227	9,1
1981	177	23562	9,8
1982	184	18620	6,6
1983	185	22075	6,9
1984	192	28966	7,7
1985	196	54785	13,1
1986	234	103408	22,2
1987	260	77950	15,3
1988	263	96660	17,1
1989	270	118064	19,1
1990	266	94333	13,8
1991	272	99081	13,3
1992	266	95861	12,2
1993	259	128470	15,9
1994	260	155810	18,2
1995	254	171668	18,6
1996	248	202732	20,6
1997	239	314721	30,7
1998	243	485187	45,4
1999	270	726566	65,6
2000	297	818384	70,2



Source: *"Fatti e Cifre della Borsa Italiana"*, Borsa Italiana Spa, 2001

Table 2 : Correlations between Monthly Returns						
	Italy	***France***	***Germany***	***UK***	***US***	***W. Europe***
Italy	1.000					
France	.641(F) .488(A) .778(B)	1.000				
Germany	.609(F) .539(A) .667(B)	.794(F) .702(A) .871(B)	1.000			
UK	.476(F) .389(A) .586(B)	.698(F) .725(A) .692(B)	.624(F) .593(A) .672(B)	1.000		
US	.362(F) .192(A) .492(B)	.600(A) .503(A) .682(B)	.567(F) .416(A) .676(B)	.685(F) .662(A) .740(B)	1.000	
W. Europe	.696(F) .589(A) .792(B)	.899(F) .869(A) .927(B)	.866(F) .826(A) .899(B)	.882(F) .908(A) .870(B)	.704(F) .632(A) .763(B)	1.000

(F): January 1990-June 2001; (A): January 1990-December 1995; (B) January 1996-June 2001
All correlations are significant at 5% level.

The ISM has some peculiar characteristics. Italian firms are reluctant to enter the stock market, and some key sectors are not represented in the market. There have been relatively few institutional investors in the ISM, with the public sector has always had a dominant role. Many financial institutions have been state-controlled and a process of privatization is now under way, contributing to the dramatic increase in market capitalization of the ISM.

The Italian legislature is making considerable efforts to encourage companies to enter the market and to align the market rules to international standards in order to attract foreign capital (there are only 6 foreign companies listed, out of a total of 297).

2.1 The Data

The data used are monthly returns (end of the month returns) for a sample of 30 shares on the Italian stock market. As shown in fig 1, the market capitalization of the shares traded in the stock market has not been representative of the Italian economy until the last few years. To form a meaningful sample, the period under consideration will be limited to the last 10 years, from the January 1990 to the June 2001 inclusive.

The sample selection criteria are chosen to form a sample representative of the Italian stock market. The sample contains all the shares of the Mib30 market index (used as a proxy for the Italian market) with no missing data in the period under consideration and a systematic selection of companies of different size and industry sectors: the sample accounts for nearly 40% of the total stock market capitalisation.

Table 3 : Data Description

Source	**DATASTREAM**
Sample period	January 1990 – June 2001 inclusive. The entire period is divided into two sub periods: • January 1990 - December 1995 • January 1996 - June 2001
Selection criteria	All the Blue Chips (Mib 30) companies with no missing data during each sub period. Systematic diversification across sectors and firm sizes.
Time interval	End of the month returns, 138 observations

The empirical tests are not performed on the monthly prices themselves, but on the first difference of their natural logarithms, in order to render the series stationary.

2.2 Normality Tests

Table 4 reports the summary statistics for the stocks in the sample. The table records mean, standard deviation, skewness and kurtosis of 31 time series (30 shares and the Mibtel market index). The test for normality is the Bera-Jarque test, which has a $\chi^2_{(2)}$ distribution under the null hypothesis of normality. The 5% critical value for $\chi^2_{(2)}$ is 5.99.

The null hypothesis of normality cannot be rejected at the 5% and 1% level of confidence in 15 and 13 cases respectively out of the 31 series. The distribution of percentage of share price changes is Gaussian in 42% of cases. This contrasts with the findings of Mandelbrot and Fama (departure from normality in every case) for the US market.

Interestingly, among the Gaussian cases, there are some of the biggest companies, for market capitalization (Fiat, Generali, Alleanza, Olivetti) and the market index itself, indicating that the returns distribution of the ISM as a whole, may be normal.

2.3 Economic Implications

Fama outlined several important theoretical differences between a market dominated by a stable Paretian[1] with $\alpha<2$ and a market dominated by a Gaussian process.

In a Gaussian market, if the sum of a large number of price changes across a long period is large, the chances are that each individual price change is negligible when compared to the total change. In a market stable Paretian with $\alpha<2$, the total price change is more likely to be the result of a few large changes during shorter sub-periods. In practice, in a stable Paretian market with $\alpha<2$, the price of a security will tend to jump up or down by large amounts during short time periods.

The economic implication of the fact that there are less frequent abrupt changes in a Gaussian market, is that the ISM is inherently less risky (less probability on the extreme tails) compared with a stable Paretian market. From a statistical point of view, if the variances of distributions of price changes are not finite, many common statistical tools, based on the assumption of finite variance, may give misleading answers. This is demonstrated by Mandelbrot in his studies on cotton prices, whose variance behaved in an erratic fashion.

[1] For a more formal and mathematical description of Stable Paretian distributions see Mandelbrot (1963)

Table 4: Summary Statistics

No	Share name	Mean	St.dev.	Skewness	Excess kurtosis	Normality
	Mibtel index	0.6284	6.8949	0.4328	0.1863	**4.4911**
1	**Fiat**	-0.2772	9.6595	-0.1175	0.5671	**3.4712**
2	**Generali**	0.7265	6.7839	0.1895	-0.2751	**1.2095**
3	**Alleanza**	1.1798	8.8098	0.1957	0.6535	**4.2246**
4	**Banca di Roma**	-0.1573	9.8029	0.3118	-0.0674	**2.5165**
5	**Gr.Ed. L'Espresso**	0.7839	14.5079	0.7153	1.7203	12.571**
6	**Fin**	-0.1043	15.8854	0.2244	4.8298	70.680**
7	**Olivetti**	-0.3085	14.2053	0.3946	0.2446	**3.7020**
8	**Ben**	0.9671	8.7106	-0.2854	0.7128	**4.7944**
9	**Dalmine**	0.3396	10.0730	1.2116	5.1123	31.989**
10	**Danieli**	-0.0198	9.3461	0.0551	0.4262	**2.3606**
11	**Jolly Hotels**	-0.1904	8.0226	0.0259	0.6499	**4.1276**
12	**Maffei**	-0.1147	8.7587	0.3995	1.2472	9.2961**
13	**Bibop Carire**	1.8185	10.5261	1.4874	5.5622	33.003**
14	**Banca Fideuram**	1.9751	12.0928	0.7958	2.4512	17.366**
15	**Edison**	1.5208	8.3763	0.2526	1.9904	19.747**
16	**Italgas**	0.8788	8.4802	0.3141	0.4560	**3.3334**
17	**Montedison**	-1.7353	15.1750	-1.3363	7.2059	47.319**
18	**Pirelli SPA**	0.5735	10.2882	-0.1970	1.5945	14.656**
19	**RAS**	0.3882	9.4629	-0.0625	-0.4460	**0.8202**
20	**SNAI**	0.7070	14.6691	1.3365	8.0456	57.475**
21	**Alitalia**	-0.2968	12.8176	0.6419	1.7174	12.473**
22	**Mondadori Ed.**	0.9468	12.1774	0.4269	4.5172	58.715**
23	**Parmalat**	0.9200	8.5661	-0.0180	1.2333	10.507**
24	**Rinascente**	0.2394	9.5157	0.9024	2.9287	20.123**
25	**SAI**	-0.0255	9.8595	0.3818	0.8603	**6.0645***
26	**Saipem**	1.1329	12.0010	0.1636	6.4676	105.35**
27	**Unicredito Italiano**	0.9757	10.1242	0.5484	0.5441	**6.7985***
28	**Pininfarina**	0.5925	10.3049	0.3070	1.6297	14.245**
29	**Zucchi**	-0.1352	8.5253	0.1754	0.5673	**3.5278**
30	**Telecom Italia**	1.7807	10.1377	0.2596	-0.4999	**3.9365**

* and ** indicate rejection of the null hypothesis of normality at 5% and 1%

For our purposes, the high number of non rejection cases of the null hypothesis of normality, which includes the market index, gives further confidence in the reliability of the usual statistical tools applied in this study.

3 EMPIRICAL TESTS OF THE CAPM AND APT

3.1 Methodology

The test used for the CAPM and APT is a two-step test, which is extensively used in the literature (see Roll and Ross (1980), Chen (1983), Lehmann and Modest (1988), Cheng (1995) and Groenewold and Fraser (1997)). The first step involves the use of time series to estimate the betas for the shares for the CAPM and a set of factor loadings through factor analysis for the APT; the second step then regresses the sample mean returns on the beta (for the CAPM) and on the factor loadings (for the APT).

3.2 Tests for the CAPM

In each period the betas are calculated through a regression using the excess returns form of the Sharpe-Lintner version of the CAPM:

$$Z_{it} = \alpha_{im} + \beta_{im} Z_{mt} + \varepsilon_{it} \tag{7}$$

The Italian official discount rate is used as a risk-free rate and the Mibtel market index as a proxy of the market portfolio. The Mibtel index is widely used as a market proxy for the ISM. It displays, during the period in consideration, a correlation of over 0.98 with the DataStream all shares and with the FT index for the Italian market: only one market proxy is thus considered in the time series regression.

To assess the model’s ability to describe the data, we run a cross-sectional regression, with the average return for each period as dependent variables and the estimated betas ($\hat{\beta}$) as independent variables (Chen (1983)):

$$\overline{R}_i = \lambda_0 + \lambda_1 \hat{\beta}_i + \eta_i \tag{8}$$

The results are displayed in Table 7. The p-values for the t test of significance are displayed below the coefficients in italics. The beta is priced at the 95% level of confidence only in the period 1996-2001, (p value 0.001), when the percentage of variance explained, represented by the adjusted R^2, is 29.7%[2]. During the 1990-95 period and in the overall ten years period, β is not significant.

This result suggests that the relationship between β and return is weak in the Italian stock market and is consistent with the findings of Fama and French (1992), Chen (1983), Cheng (1995) and Groenewold and Fraser (1997) for the US, UK and Australian stock markets respectively.The weak explanatory power displayed by β suggests that additional variables may be needed to explain the behavior of shares prices in the ISM.

3.3 Tests for the APT

The number of factors and factor loadings in the APT model are determined through Principal Component Analysis (PCA). The software used is SPSS 8.0 for windows. We report only the methodology used for the 10-year general case, as the procedure used for the sub periods is analogous.

The matrix **X** in our test is the (138,30) matrix formed by the 30 share vectors (each vector has 138 components, corresponding to the 138 monthly observations).The Kaiser-Meyer-Olkin test (KMO) value for the sample is very high (.908) and Barlett test of sphericity is significant at 99% level, indicating that the factor analysis is an appropriate technique for our data.

Table 6 shows the eigenvalues, which represent the proportion of total variance in all the variables that is accounted for by that factor. To decide the number of factors to retain, both the scree test and the Kaiser criterion[3] were used. In our case the "Total variance explained table" shows that there are 5 dominant factors whose eigenvalues are more than one. In particular the first three factors account respectively for the 39.4%, 7.1% and 4.3% of the total variance.

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[2] We use the Adjusted R^2 as a measure of the total variance explained by the models to adjust for the fact that a large number of exogenous variables can artificially produce a high R^2 causing in our case bias toward the APT.

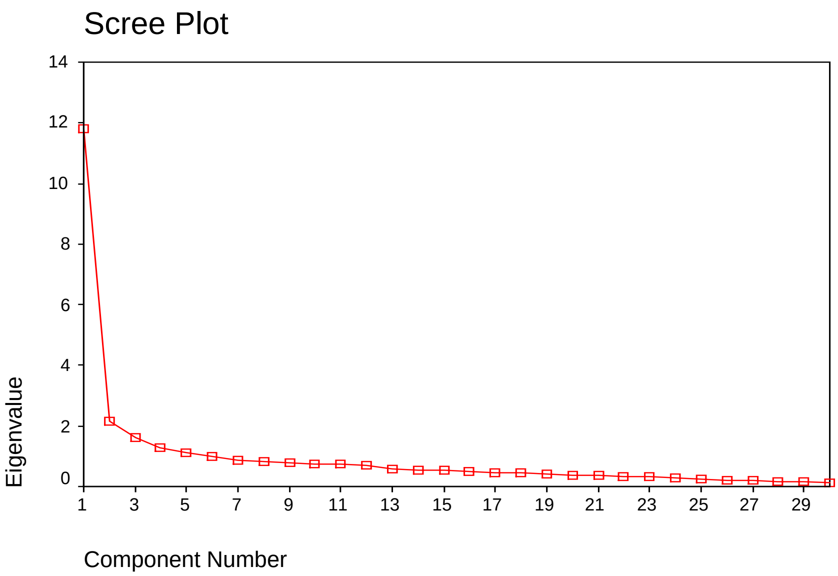
[3] The Kaiser criterion consists in dropping the eigenvalues less than one.

Looking at the scree plot (that plots the eigenvalues for each component) we see that after the 5th factor the eigenvalues are decreasing slowly. Following standard practice, we retain the first 5 factors, corresponding to the 5 first eigenvectors, and accounting for nearly 60% of the total variance.

Table 6 : Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Components	**Total**	**% of Variance**	**Cum. %**	**Total**	**% of Variance**	**Cum. %**
1	11.812	39.374	39.374	11.812	39.374	39.374
2	2.138	7.127	46.501	2.138	7.127	46.501
3	1.618	5.392	51.893	1.618	5.392	51.893
4	1.287	4.291	56.184	1.287	4.291	56.184
5	1.120	3.734	59.918	1.120	3.734	59.918
6	1.000	3.334	63.252			
7	.888	2.961	66.214			
8	.812	2.707	68.920			
9	.791	2.635	71.555			
10	.741	2.471	74.027			
….	….	….	….			
29	.161	.537	99.567			
30	.130	.433	100.000			

Figure 2 : Scree Plot



The eigenvalue analysis suggests that there are 5 dominant factors affecting the behavior of share prices in the ISM and that one of these factors has prominent importance, explaining nearly 40% of the total variance.

To test the model, we examine in the second step the results of the cross sectional regression of average assets' returns on the estimated factor loadings ($\hat{b}$) as independent variables (Chen (1983)):

$$\overline{R}_i = \lambda_0 + \lambda_1 \hat{b}_{i1} + \lambda_2 \hat{b}_{i2} + \lambda_3 \hat{b}_{i3} + \lambda_4 \hat{b}_{i4} ... + \lambda_5 \hat{b}_{i5} + \varepsilon_i \quad (9)$$

The results of the regression are shown in Table 7. Significance levels (p-values), are reported in italics. The APT is overall significant (F statistic) and outperforms the CAPM in every period: curiously, its worst performance is in the only period that the beta of the CAPM is priced. In fact, the only factor priced with more than 95% significance in this period is factor 2.

In the period 1990-95, factors 2,3,4 are statistically significant, while in the overall period 1990-2001, factors 4 and 5 are priced. The adjusted R^2 coefficients for the APT in 1990-1995 and 1990-2001 are respectively 47% and 43.8%. This is a considerable improvement compared with the lack of explanatory power of the CAPM in the same periods.

Table 7 : Cross-sectional Regression of Returns

CAPM

$$\overline{R}_i = \lambda_0 + \lambda_1 \hat{\beta}_i + \eta_i$$

PERIOD	λ_0	λ_1	**Adj** R^2
01/90-12/95	-0.155 *-0.8600*	-0.152 *0.8712*	-0.035
01/96-06/01	-0.209 *-0.6544*	1.787 *0.0011*	0.297
01/90-06/01	0.445 *0.5170*	0.064 *0.9312*	-0.035

APT

$$\overline{R}_i = \lambda_0 + \lambda_1\hat{b}_{i1} + \lambda_2\hat{b}_{i2} + \lambda_3\hat{b}_{i3} + \lambda_4\hat{b}_{i4} + \lambda_5\hat{b}_{i5} + \varepsilon_i$$

PERIOD	λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	**Adj** R^2	**F**	**sig.**
01/90-12/95	-1.097	1.408	-1.746	2.173	-2.276	-0.312	0.470	6.153	0.001
	0.2810	*0.3568*	***0.0229***	***0.0082***	***0.0343***	*0.7104*			
01/96-06/01	2.340	-1.626	1.530	-1.384	-1.182	-1.142	0.319	3.714	0.012
	0.0530	*0.3832*	***0.0143***	*0.1243*	*0.1192*	*0.1881*			
01/90-06/01	0.146	0.602	0.949	-1.204	-1.271	-1.621	0.438	5.517	0.002
	0.8890	*0.7149*	*0.0928*	*0.0750*	***0.0230***	***0.0100***			

The resulting equations (using monthly intervals) for the ISM in the period January 1990-June 2001, are

$$E[R_i] = 0.445 + 0.064\beta_i \tag{10}$$

for the CAPM and

$$E[R_i] = 0.146 + 0.602b_{i1} + 0.949b_{i2} - 1.204b_{i3} - 1.271\lambda_4 b_{i4} - 1.621b_{i5} \tag{11}$$

for the APT.

4 COMPARISON BETWEEN CAPM AND APT

The next step is to assess which one of the two competing models, CAPM or APT is supported by the data. Following the approach used by Chen (1983), we use three methods, the Davidson and Mackinnon equation, the posterior odds ratio and the residual analysis.

4.1 Davidson and MacKinnon Equation

The CAPM could be considered as a particular case of the theoretical APT with k=1 and $b_1 = \beta$. However, when we consider the APT with artificial factors, this is true if and only if there exists a rotation of the factors such that one of the factors is the "market". The two models, CAPM and APT, are thus defined as "non-nested". One method to discriminate among non-nested models was suggested in Davidson and MacKinnon (1981).

Let R_{APT} and R_{CAPM} be the expected returns generated by the APT and the CAPM, and consider the following equation

$$R_i = \alpha R_{APT} + (1-\alpha) R_{CAPM} + e_i \tag{12}$$

where α is a measure of the effectiveness of the two methods. When α is close to 1, the APT is the correct model relative to the CAPM.

The results of the regression, reported in Table 8, are heavily in favour of the APT, with the possible exception of the period 1996-2001, for which the odds in favour of the APT are less substantial.

Table8 : Estimated α from the Davidson and MacKinnon Equation

PERIOD	α
01/90-12/95	0.995 *0.0000*
01/96-06/01	0.710 *0.0113*
01/90-06/01	1.004 *0.0000*

The Davidson and MacKinnon (DM) equation has been criticized because, even if the models are non-nested, there is still a risk of multicollinearity between the variables as the β of the CAPM could be strongly correlated with APT factors. However, the method has been extensively applied in the literature (see Chen (1983), Groenewold and Fraser (1997)).

4.2 Posterior Odds Ratio

Given the assumption that the residuals of the cross-sectional regression of the CAPM and the APT satisfy the IID multivariate normal assumption, it is possible to calculate the posterior odds ratio between the two models. In general, the formula for posterior odds in favour of model 1 over model 0 is given by (Zellner (1979)):

$$R = \left[\frac{ESS_0}{ESS_1}\right]^{\frac{N}{2}} N^{\frac{(k0-k1)}{2}} \tag{13}$$

where ESS is the error sum of squares, N is the number of observations, and k is the dimension of respective models.

The posterior odds computed are overwhelmingly in favour of the APT and range from 7.26E+09 for the period 1996-2001 to 9.1767E+28 for period 1995-2001.The posterior odds ratio is in general a more formal method than the DM equation and has sounder theoretical foundations.

4.3 Residual Analysis

The residuals from the CAPM are of interest as they are used for performance measurement. If the CAPM is not misspecified, the expected return of an asset *i* would be captured by β_i and the residual η_i will behave like white noise with zero mean across time.

Thus, if expectations in the market are rational, the realized return can be written as

$$R_i = E_i + \nu_i \tag{14}$$

where E_i is the market rational expected return and ν_i is the error term. If the CAPM is not misspecified, R_i can also be written also as (Chen 1983)

$$R_i = E_i(CAPM) + \eta_i \tag{15}$$

Thus

$$\eta_i = \left[E_i - \widehat{E}_i(CAPM)\right] + \nu_i \tag{16}$$

where $\widehat{E}_i(CAPM)$ is the expected return from the CAPM with the market proxies. If the CAPM is correct then $E_i = \widehat{E}_i(CAPM)$ and $\eta_i = \nu_i$ should behave like white noise and should not be priced by any other models. If η_i is priced by any other model, E_i contains information that is not captured by $\widehat{E}_i(CAPM)$ and the CAPM is misspecified. Therefore, a logical method to test the CAPM is to run a regression with η_i (the residuals of the CAPM) as dependent variable and the factor loadings of the APT as independent. We then run an analogous regression of the APT residual on the CAPM β to check if the CAPM prices information missed by the APT.

The results, reported in Table 9, are clearly in favour of the APT. The APT explains, in the periods 1990-95 and 1990-2001, 47.7% and 43.1% respectively of the variance unexplained by the CAPM. As expected, the worst performance of the APT is in the period 1996-2001, when the variance explained is only 17%: this is the only period when β is priced and has explanatory power. The CAPM fails to explain the variance of APT residuals in all the periods.

However, care is needed when looking at the results in Table 9. Table 7 and 9 are strictly connected. Any factor not priced in Table 7 should not be priced in Table 9. If a factor is not priced with the original data, but is priced in the regression of η_i on the $\widehat{b}_i$, the estimated λ may be spuriously induced by $\hat{\beta}_i$.

Analyzing Table 9A and 7, we see that in 1996-2001 factor 2 is priced in the cross sectional regression but not in the residual regression, where factor 1 is priced. This result is dubious and this is confirmed by the significance of the overall regression in that period (significant at 90% but not at the 95% level). In periods 1990-1995 and 1990-2001, factors 2,3,4 and 4,5 are priced in both regressions. This result strongly supports the ability of the APT to explain information not captured by the CAPM.

Table 9 : Regression of Residuals

A. Of the CAPM on the Factor Loadings

$$\eta_i = \lambda_0 + \lambda_1 \hat{b}_{i1} + \lambda_2 \hat{b}_{i2} + \lambda_3 \hat{b}_{i3} + \lambda_4 \hat{b}_{i4} + \lambda_5 \hat{b}_{i5} + \varepsilon_i$$

PERIOD	λ_0	λ_1	λ_2	λ_3	λ_4	λ_5	Adj R^2	F	sig.
01/90-12/95	-0.950	1.634	-1.710	2.126	-2.220	-0.330	0.477	6.293	0.001
	0.3456	*0.2829*	*0.0246*	*0.0090*	*0.0374*	*0.6926*			
01/96-06/01	2.936	-4.699	-0.118	-1.590	-1.185	-1.162	0.170	2.185	0.089
	0.0102	*0.0095*	*0.8248*	*0.0558*	*0.0876*	*0.1425*			
01/90-06/01	-0.307	0.522	0.915	-1.203	-1.292	-1.621	0.431	5.402	0.002
	0.7699	*0.7524*	*0.1059*	*0.0761*	*0.0212*	*0.0102*			

B. Of the APT on Beta

$$\varepsilon_i = \lambda_0 + \lambda_1 \hat{\beta}_i + \eta_i$$

PERIOD	λ_0	λ_1	Adj R^2
01/90-12/95	0.435	-0.480	-0.013
	0.4528	*0.4352*	
01/96-06/01	-0.385	0.435	-0.001
	0.3608	*0.3308*	
01/90-06/01	0.568	-0.634	0.027
	0.2022	*0.1917*	

5 APT AND MACROECONOMIC FACTORS

The APT itself does not provide specific guidance on the choice of macroeconomic factors, and the approach to the choice of factors has usually been to some extent arbitrary and controversial. The economic interpretation of the common factors is probably the most important direction for future research (Chen 1983).

The first real systematic approach to finding significant macroeconomic factors is due to Chen, Roll and Ross (1986). They assumed that the systematic forces that influence returns are those that change the expected cash flows and the discount factors. They identified 5 macroeconomic variables that affected share returns in the NYSE, during the period 1958-84: industrial production, change in expected inflation, unexpected inflation, risk premium and term structure of interest rates. They used, for the first time, factor analysis to analyze the major macroeconomic variables affecting the US economy.

Groenewold and Fraser (1997) chose the macroeconomic variables based on the general hypothesis that returns are influenced by three classes of factors: real domestic activity, nominal domestic influences and foreign variables. They found that securities in the Australian stock markets are affected mainly by inflation rate and by monetary variables.

An interesting and revolutionary approach is the one used by Cheng (1995). Cheng performed a factor analysis of both a sample of securities and of the major categories of macroeconomic variables in the UK stock market in the period 1965-1988. He then compared the two sets of factors obtained looking for significant correlation through canonical correlation techniques.

In general, the use of factor analysis as an exploratory tool to attribute a meaning to the artificial factors is a powerful and relatively new approach that offers considerable potentialities. Our analysis of the factor structure of the Italian economy will be centered on the theory developed by Chen et al. (1986) and Cheng (1995).

5.1 The Factor Structure of the Italian Economy

We performed in section 3.3 a factor analysis of the share sample. In this section we perform a similar analysis on a representative set of Italian economic variables to estimate the number and the loadings of factors that may represent the Italian economy. In general, as outlined above, many of the variables found significant in empirical studies for different markets overlap, namely: inflation, interest rates, money variables, market indices, production indices and international trade variables.

The variables in our analysis (Table 10) are chosen taking into account the empirical literature in order to cover a wide spread of economic processes and sectors in the economy. We consider the first difference of macroeconomic variables, in order to render the series stationary and to facilitate comparison with stock returns.

We then perform a principal component analysis of the set of macroeconomic variables of the Italian economy. The are 8 factors with eigenvalues more than one, accounting for over 72% of the total variance. Having found the significant factors, we rotate the original base. We chose an oblique rotation method, as we expect macroeconomic variables to be correlated. Table 10 summarizes the factor loadings.

From Table 10 it is easy to appreciate the power of factor analysis. We can interpret now the factors that are the drivers of economic activity. A factor is affected by the economic variables that have high loadings on it.

Table 10 Factor Loadings

	1	2	3	4	5	6	7	8
Mibtel	**0.931**	-0.066	0.014	0.018	-0.001	-0.001	-0.027	0.059
Exchus	0.129	0.097	-0.048	**0.850**	-0.010	-0.142	-0.092	0.091
Dsccong	**0.871**	-0.014	-0.052	0.063	-0.053	-0.046	-0.008	0.146
Dsnccong	**0.844**	-0.108	-0.053	0.041	-0.137	-0.036	0.007	-0.100
Dsbind	**0.852**	-0.145	-0.099	-0.023	-0.001	-0.053	-0.001	0.127
Dsgenin	**0.882**	0.087	-0.068	0.016	0.046	-0.008	-0.001	0.112
Dsfin	**0.910**	-0.062	0.018	-0.006	0.005	-0.022	-0.071	0.015
Gdp	-0.153	0.106	-0.007	0.085	**0.818**	0.093	-0.038	0.225
Gvbondy	-0.077	**0.844**	-0.363	-0.019	0.018	-0.014	-0.022	0.098
Cbondy	-0.161	**0.856**	0.085	0.015	-0.005	-0.088	0.008	0.133
Indprod	0.004	-0.141	-0.016	0.106	0.069	0.007	**-0.884**	-0.075
M1	-0.073	0.281	0.462	0.010	**-0.547**	0.003	-0.190	0.346
Conexp	0.019	-0.064	-0.125	0.035	-0.148	**-0.747**	0.144	-0.064
Inf	0.055	0.162	0.172	-0.013	0.117	**-0.647**	-0.150	-0.032
Stbills	-0.094	**0.752**	0.020	-0.122	-0.040	0.014	0.071	-0.112
Imp	0.019	0.161	0.109	**-0.648**	0.131	-0.107	0.071	-0.029
Exp	0.006	-0.042	-0.173	**-0.844**	-0.164	-0.007	-0.055	0.124
Discrate	0.014	**0.606**	0.037	-0.014	0.216	-0.047	0.049	-0.346
FTEU	**0.722**	0.075	0.368	0.106	0.051	0.163	0.131	-0.098
FTUS	0.395	0.099	**0.571**	-0.073	0.033	0.276	0.013	-0.162
Annindprod	0.087	0.065	0.101	-0.245	**0.585**	-0.185	**-0.419**	0.050
Leadind	0.123	-0.205	0.052	-0.026	0.138	0.115	-0.073	**0.659**
Busprosp	0.266	0.097	-0.061	0.046	0.104	0.014	0.201	**0.661**
RP	-0.113	-0.183	**0.790**	0.060	-0.040	-0.110	0.052	0.030
TS	0.041	0.395	-0.389	-0.041	-0.189	0.215	**-0.404**	-0.050

The results of this analysis suggest there are 8 major factors underlying the Italian economy:

- **first factor:** encompasses general market variables and includes various market indices- Mibtel, Financial times European index (FTEU), Datastream equity indices of cyclical and non-cyclical consumer good (Dsccong, Dsnoccong), basic and general industrial (Dsbind, Dsgind), and financial sectors (Dsfin). This finding is consistent with previous finding of correlation of the ISM with the European stock markets and indicates influence of the latter on the ISM. We call the first factor the **market portfolio factor**.
- **Second factor**: consists mainly of government and corporate bond yield (Gvbondy, Cbondy), short term bills yield (Stbills) and Italian official discount rate (Disrate). We will call the second factor the **fixed income securities factor.**
- **Third factor:** consists of the Financial Times US market index (FTUS) and of the risk premium (RP, corporate minus government bond yield). This factor is difficult to interpret even with the oblique rotation. We may probably interpret this factor as the sensitivity to risk premium changes over time.
- **Fourth factor:** encompasses the exchange rate with the US (Exchus) and import and export price indices (Imp, Exp). It may be interpreted as the factor representing the impact of **foreign variables** on the Italian economy.
- **Fifth factor:** is related to the GDP, money supply (M1) and annual industrial production and can be labelled the **production and monetary** factor.
- **Sixth factor:** is related to inflation (Inf) and consumer expenditure (Conexp). We call it the **inflation** factor.
- **Seventh factor:** is related to the industrial production and, to a lesser extent, to the term structure of interest rates (TS). It can be defined as the **industrial production** factor.
- **Eighth factor:** probably the most interesting factor because it is usually overlooked. It is related to the leading indicators (Leadind), that is a leading index indicating trends about one year in advance, composed of various economic factors, and business prospects (Busprosp) a survey index indicating confidence on future business activity. This factor can be interpreted as the **people's expectation** factor. The first to include a people's expectation factor in his analysis is Cheng (1995) and the fact that it is a stand alone factor seems to indicate that this is a significant factor in the economy.

The reduced form of the macroeconomic model demonstrates that there is additional information in the economy not explained by the market portfolio. The factor analysis seems to be a powerful explanatory tool: the relationships between the macroeconomic variables in each of the eight factors seem to follows closely the logic of economic activity.

5.2 The Economic Determinants of Stock Returns

To assess whether asset prices are related to economic variables we follow the methodology of Chen (1983) and Chen et al. (1986). However, the approach is innovative in taking advantage of the categorisation given by the factor analysis in order to choose macroeconomic factors with maximum amount of independent explanatory information associated and to avoid risks of multicollinearity.

The factors may be interpreted as portfolios constructed to capture common comovements in stock market returns. We know that the factor scores are the coefficients used in the linear combination of the variables to form the factors. Thus if we consider the factor score coefficients it is possible to calculate the time series of the five share factors with the following formula:

$$FS_{jt} = \sum_{i=1}^{n} W_{ij} Z_{it} \tag{17}$$

where n is the number of shares, FS_{jt} is the factor score of j share factor at time t, W_{ij} is the factor score coefficient that indicates how much the ith variable (share) is reflected in the jth factor, and Z_{it} is the standardized return of ith share at time t.

Our objective is to find the relationships between the artificial factors and macroeconomic variables. We know from the factor analysis performed on the share sample that there are 5 pervasive factors affecting share prices in the ISM. The explanation of the identity of factors can be translated in finding 5 significant macroeconomic variables (EC) in the regression equation

$$FS_{jt} = \lambda_0 + \lambda EC_{1t} + \lambda_2 EC_{2t} + \lambda_3 EC_{3t} + \lambda_4 EC_{4t} + \lambda_5 EC_{5t} + \varepsilon_{jt} \tag{18}$$

such as the APT model is overall significant for all the FS_j, with j=1..5. An economic variable is considered significant if and only if it is significantly related to at least one of the five common stock factors, and the null hypothesis of non validity of the test is that the five regression coefficients are jointly zero.

We choose the economic variables using the categorization of the Italian economy provided by the factor analysis. We must choose variables related to 5 different artificial factors in order to form a base of macroeconomic variables that allows minimum overlapping and maximum amount of independent information in each single variable. Following this procedure, the null hypothesis was rejected for the following 5 variables APT equation:

$$FS_{jt} = \lambda_0 + \lambda_1 MIBTEL_t + \lambda_2 STBILLS_t + \lambda_3 INF_t + \lambda_4 IMP_t + \lambda_5 LEADIND_t + \varepsilon_{jt} \quad (19)$$

The results of the regression, and the level of significance of the economic variables are reported in Table 11.

Table 11 : Significance of Economic Variables

FACTOR	λ_0	λ_1 MIBTEL	λ_2 STBILLS	λ_3 INF	λ_4 IMP	λ_5 LEADIND	F	sig.
FS1	-0.379	**0.526**	**-3.335**	4.789	**0.410**	-0.239	9.808	5.47E-08
	0.5860	***0.0000***	***0.0072***	*0.1377*	***0.0119***	*0.8594*		
FS2	1.196	**0.460**	-1.067	-5.091	-0.237	-2.259	5.161	2.34E-04
	0.1302	***0.0003***	*0.4411*	*0.1626*	*0.1936*	*0.1401*		
FS3	1.426	**0.962**	0.359	**8.703**	-0.214	-0.235	11.337	4.12E-09
	0.1317	***0.0000***	*0.8286*	***0.0470***	*0.3264*	*0.8975*		
FS4	-1.363	**1.039**	**6.291**	-8.793	-0.195	0.567	10.552	1.54E-08
	0.1771	***0.0000***	***0.0005***	*0.0601*	*0.4029*	*0.7711*		
FS5	-1.532	**0.374**	0.866	2.785	-0.037	**3.992**	4.357	1.06E-03
	0.0574	***0.0035***	*0.5385*	*0.4516*	*0.8421*	***0.0110***		

These results are interesting and consistent with the previous findings. Share prices are affected by 5 different classes of factors: market portfolio factor (Mibtel), fixed income securities factor (Stbills), inflation factor (Inf), foreign variable factor (Imp) and people's expectations factor (leaddind). It is interesting to note that, consistent with the CAPM, the market portfolio factor is the only one that affects significantly all the factors. But in every factor, except in number 2, the Mibtel is priced together with at least one other factor.

Factor 1 is the most important factor, accounting for nearly 40% of the variance. There are 3 significant economic variables in it: market index, fixed income securities and import price index. This is consistent with the reality of Italian economy that depends on imports for most of its raw materials and oil.

Inflation is significant in factor 4. This is consistent with previous findings in the literature: Beenstock and Chan (1988), Ariff and Johnson (1990), Clare and Thomas (1994), Groenewold and Fraser (1997) and Chen (1995) found it is a significant factor in the US, UK and Australian stock markets. Finally, the 5th factor represents the contribution of expectations in influencing and affecting share prices.

In conclusion, even if the market return is an important factor, securities' returns are significantly influenced by a number of systematic forces and their behaviour can be explained only through the combined explanatory power of several macroeconomic variables.

6 CONCLUSIONS

The analysis of the chosen sample shows that over 40% of the shares, together with the Mibtel market index, are normally distributed. This is an important finding, suggesting that the returns distribution of the ISM as a whole may be normal, in contrast with the findings of Mandelbrot (1963) and Fama (1965), which are widely accepted in the modern financial theory.

The relationships between β and return in the ISM in the period January 1990 – June 2001 is weak, and the Capital Asset Pricing Model displays poor explanatory power. It is however difficult to assess to what extent this depends on the specification of the model itself. The apparent low informational efficiency of the ISM (Brunetti (1999)), the fact that there are few institutional investors, and that private investors in Italy often regard the stock market more as a place to gamble than to invest, could cause market "irrationality", undermining the assumptions upon which the CAPM is based.

The Arbitrage Pricing Theory performs better, compared to the CAPM, in all the tests considered. From the evidence gathered in this study, the APT is a more powerful method that allows consideration of the risk borne on additional systematic “state variables”, other than the market portfolio.

The percentage of variance explained in the full period of observation (43.8%) can be considered a good result compared with the results obtained by Chen (1985) in the US stock market (results ranging from 4% to 27.8% in different sub-periods from 1963 to 1978) and Cheng (1995) in the UK (11% in the period January 1965 - December 1988).

Five factors have been found relevant in the APT model, with the first factor explaining nearly 40% of the total variance. The significant macroeconomic variables in the Italian stock market overlap considerably with factors found relevant on other countries (market portfolio, fixed income securities, inflation, imports), with the interesting relevance of the factor representing people’s expectation, introduced for the first time in the APT studies of Chen (1995).

The study was originally designed to compare CAPM and APT, but one of the main results obtained, I think, is the appreciation of the wide range of potentialities offered by a relatively new tool used in testing the APT: factor analysis. If the identification of the number of factors and their identity is one of the most important directions for future research (Chen 1983, Chen, Roll and Ross 1986), factor analysis techniques, I believe, are a powerful instrument to replace the arbitrary and controversial search for factors by *“trial and error”* with a real systematic approach.

The reduced form of the macroeconomic model in Table 10 shows the importance of factor analysis in identifying and categorizing the main drivers of economic activity. The relationships between the macroeconomic variables in each of the eight factors follow closely the logic of economic activity and allow us to understand what are the driving forces, and where the explanatory power is.

The overall conclusion of the study is that even if the market return is an important element, the behaviour of securities returns in the ISM is complex and cannot be fully explained by a single factor. Shares and portfolios are significantly influenced by a number of systematic forces and their behaviour can be explained only through the combined explanatory power of several factors or macroeconomic variables.

Considering that the APT explains less than 44% of the overall variance, we can ask ourselves where the missing information is, and why the APT fails to explain fully the returns covariances and mean returns.

There can be several possible explanations (Cheng (1995)). First, risk and expected return may not be stationary during the period in consideration, while one of the assumptions in the study of the APT is that risk and expected returns are assumed not to change during the period. Second, the APT pricing relationship could hold only in some months of the year, and there is evidence of a *"January effect"* on the capability of the APT to explain the return-risk relationship (Gultekin and Gultekin (1987)).

Third, and in my opinion more probable, there is the possibility of non-linear pricing relationships. The assumption of linear relationships between the APT and factors or macroeconomic variables is a strong assumption, which is often overlooked. The linear model is a simple model, ideal to explain observed correlations. If instead the objective is to predict mean returns, higher-order factors models would provide more accurate predictions as minor factors relatively unimportant in explaining covariances, may be fundamental to explain mean returns. These, I think, may be important directions in future research.

REFERENCES

1. Ariff, M., Johnson, L.W., *"Security Market and Stock Pricing"*, Longman, 1990
2. Bachelieu, L.J.B.A, *"Le Jeu, la Chance et le Hasard"*, Flammarion, 1914
3. Bachelieu, L.J.B.A, *"Theorie de la speculation"*, Paris, Gauthier-Villars, 1900.
4. Beenstock, M., Chan, K. *"Economic Forces in the London Stock Market"*, Oxford Bulletin of Economics and Statistics, Vol.50, 1988
5. Black, F., *"Beta and Return"*, Journal of Portfolio Management, Fall 1993
6. Black, F., Jensen, M., Scholes, M., *"The Capital Asset Pricing Model:Some Empirical Tests"*, in Jensen, M., *Studies in The Theory of Capital Markets*, Praeger, New York, 1972
7. Borsa Italiana Spa, *"Fatti e Cifre della Borsa Italiana"*, 2000

8. Brunetti, C., *"The Italian Stock Market: a Cross Country Comparison"*, working paper 99.3, 1999
9. Chen, N. F., *"Some Empirical Tests of Arbitrage Pricing"*, Journal of Finance, Vol.38, 1983
10. Chen, N.F., Roll, R., Ross, S.A., *"Economic Forces and the Stock Market*", Journal of Business, Vol. 59, 1986
11. Cheng, A.C.S., *"The UK Stock Market and Economic Factors: a New Approach"*, Journal of Business Finance and Accounting, Vol.22, 1995
12. Clare, A.D., Thomas, S.H., *"Macroeconomic Factors: the APT and the UK Stock Market*", Journal of Business Finance and Accounting, Vol.21, 1994
13. Davidson, R., MacKinnon, J., *"Several Tests for Model Specification in the Presence of Alternative Hypotheses"*, Econometrica, Vol. 49, 1981
14. Dhrymes, P.J., Friend,I., Gultekin, N. B., *"A Critical Reexamination of the Empirical Evidence on the Arbitrage Pricing Theory"*, Journal of Finance, Vol. 39, 1984
15. Fama, E.F. *"Mandelbrot and the Stable Paretian Hypothesys"*, Journal of Business, Vol. 36, 1963
16. Fama, E.F., *"The Behaviour of Stock Market Prices"*, Journal of Business, Vol. 38, 1965.
17. Fama E.F., *"Multifactor Portfolio Efficiency and Multifactor Asset Pricing"*, Journal of Financial Quantitative Analysis, Vol. 31, 1996
18. Fama E.F., French K.R., *"The Cross-section of Expected Stock Returns"*, Journal of Finance, Vol. 47, No. 2, 1992
19. Fama E.F., French, K.R., *"The CAPM is Wanted, Dead or Alive"*, Journal of Finance, Vol. 51, 1996
20. Fama, E. F., MacBeth, J. D., **"***Risk, Return, and Equilibrium: Empirical Tests",* The Journal of Political Economy, Vol. 81, 1973
21. Gnedenko, B.V., Kolmogorov, A.N., *"Limit Distributions for Sums of Indipendent Random Variables"*, Addison-Wesley, 1954
22. Groenewold, N., Fraser, P., *"Share Prices and Macroeconomic Factors"*, Journal of Business Finance and Accounting, Dec. 1997
23. Grundy, K., Malkiel, B.G., *"Reports of Beta's Death Have Been Greatly Exaggerated"*, Journal of Portfolio Management, Vol. 22, 1996
24. Gultekin, M.N., and Gultekin, N.B., "Stock Returns Anomalies and the Tests of the APT", Journal of Finance, Vol.42, 1987
25. Holt, J., *"Motion Sickness: a Randow Walk from Paris To Wall Street"*, Lingua Franca, 1997, in www.linguafranca.com
26. Kothari, S.P., Shanken, J., Sloan, R.G., *"Another Look at the Cross-section of Expected Stock Return"*, Journal of Finance, Vol.50, 1995

27. Lehmann, B., Modest, D., *"The Empirical foundations of the Arbitrage Pricing Theory"*, Journal of Financial Economics, Vol. 21, 1988

28. Mandelbrot, B., *"The Variation of Certain Speculative Prices"*, Journal of Business, Vol.36, 1963

29. Markowitz, H. M., *"Portfolio Selection"*, Journal of finance, Volume 7 ,1952

30. Osborne, M.F. M., *"Brownian Motion in the Stock Market"*, Operation Research, Vol.7, 1959

31. Roll, R., *"A critique of the Asset Pricing Theory's Tests"*, Journal of Financial Economics, Vol.4, 1977

32. Roll, R., Ross, S. A., *"The Arbitrage Pricing Theory Versus The Capital Asset Pricing Model"*, Public Utilities Fortnightly 111, 1983

33. Roll, R., Ross, S.A., *"A Critical Reexamination of the Empirical Evidence on the Arbitrage Pricing Theory"*, Journal of Finance, Vol. 39, 1984

34. Ross, S.A., *"The Arbitrage Theory of Capital Asset Pricing",* Journal of Economic Theory, Vol.13, 1976

35. Shanken, J. *" The Arbitrage Pricing Theory: Is It Testable?"*, Journal of Finance, Vol. 37, 1982

36. Sharpe, W.F., *"Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk"*, Journal of Finance, Vol.19, 1964

37. Sharpe, W.F., *"Revisiting the Capital Asset Pricing model"*, an Interview by Jonathan Burton, Dow Jones Asset Manager, May-June 1998

38. Zellner, A., *"Posterior Odds Ratios for Regression Hypotheses: General Considerations and Some Specific Results"*, Working Paper, University of Chicago, 1979